Effect of solution combustion synthesized ZnAl$_2$O$_4$ powder on the properties of electrodeposited Ni and Ni-composite coating

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Abstract

In recent years, there has been increased interest in the research and development of metal matrix composite coatings (MMCs) due to their expected engineering applications. These composite coatings can impart functional properties such as wear, corrosion and oxidation resistance, dispersion hardening or self-lubrication relative to pure metal. As a result of which, MMCs can protect the metal substrates more effectively against severe environments during operation and also they can impart some functional properties. Zinc aluminate (ZnAl$_2$O$_4$), a member of spinel family offers many advantages such as high thermal and chemical stability, hydrophobic behavior, high mechanical resistance, low sintering temperature and high quantum yield and it is used as transparent conductor, dielectric material and optical material. The tribological property of the ZnAl$_2$O$_4$ nanoparticles as an additive in lubricant oil has been recently evaluated with four-ball test and thrust-ring test. However, there are no reports on the synthesis and properties of electrodeposited Ni-ZnAl$_2$O$_4$ coatings. ZnAl$_2$O$_4$ particles were synthesized by solution combustion method. A black solar selective coating with $\alpha=0.927$ and $\varepsilon=0.16$ was obtained from a nickel sulfaminate bath with the addition of as synthesized ZnAl$_2$O$_4$ particles without any pretreatment of particles. The reason for this was analyzed and the coating was found to be Ni-Zn alloy instead of Ni-ZnAl$_2$O$_4$ composite coating. However, upon washing the powder thoroughly in water and drying, the particles could be incorporated into the Ni matrix. Ni-ZnAl$_2$O$_4$ coatings were obtained at various applied current densities. A microhardness 429 KHN was observed for the coating electrodeposited at 0.75A/dm$^2$ and the wear resistance of this coating was found to be better than the coating without any particles. In general microhardness values decreased with increased applied current density. The corrosion resistance of the coatings as a function of applied current density was also studied.

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